1.3 Exercise Set

In Exercises 1–4, the table of data contains input–output values for a function. Answer the following questions for each table.

a) *Is the change in the inputs x the same?*
b) *Is the change in the outputs y the same?*
c) *Is the function linear?*

1.

x	y
−3	7
−2	10
−1	13
0	16
1	19
2	22
3	25

2.

x	y
20	12.4
30	24.8
40	49.6
50	99.2
60	198.4
70	396.8
80	793.6

3.

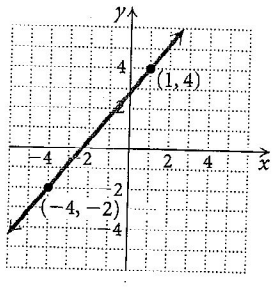
x	y
11	3.2
26	5.7
41	8.2
56	9.3
71	11.3
86	13.7
101	19.1

4.

x	y
2	−8
4	−12
6	−16
8	−20
10	−24
12	−28
14	−32

Find the slope of the line containing the given points.

5.



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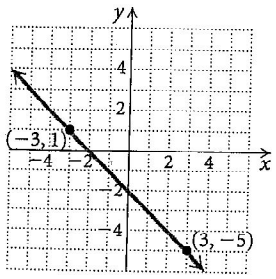

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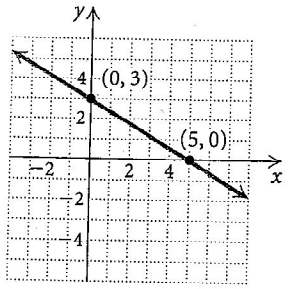
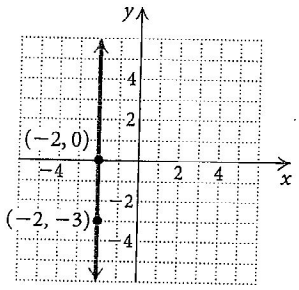
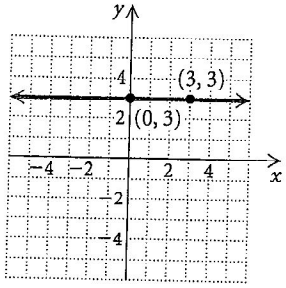


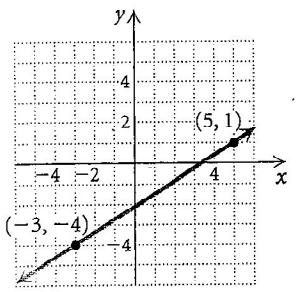
8.



9.



10.

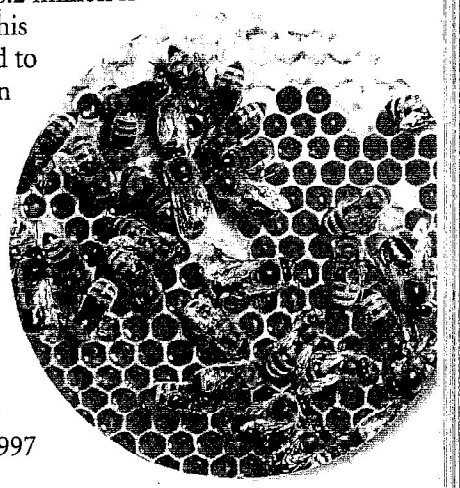


11. $(9,4)$ and $(-1,2)$
12. $(-3,7)$ and $(5,-1)$
13. $(4,-9)$ and $(4,6)$
14. $(-6,-1)$ and $(2,-13)$
15. $(0.7,-0.1)$ and $(-0.3,-0.4)$
16. $\left(-\frac{3}{4},-\frac{1}{4}\right)$ and $\left(\frac{2}{7},-\frac{5}{7}\right)$
17. $(2,-2)$ and $(4,-2)$
18. $(-9,8)$ and $(7,-6)$
19. $\left(\frac{1}{2},-\frac{3}{5}\right)$ and $\left(-\frac{1}{2},\frac{3}{5}\right)$
20. $(-8.26,4.04)$ and $(3.14,-2.16)$
21. $(16,-13)$ and $(-8,-5)$
22. $(\pi,-3)$ and $(\pi,2)$
23. $(-10,-7)$ and $(-10,7)$
24. $\left(\sqrt{2},-4\right)$ and $(0.56,-4)$
25. $f(4)=3$ and $f(-2)=15$
26. $f(-4)=-5$ and $f(4)=1$
27. $f\left(\frac{1}{5}\right)=\frac{1}{2}$ and $f(-1)=-\frac{11}{2}$
28. $f(8)=-1$ and $f\left(-\frac{2}{3}\right)=\frac{10}{3}$

Determine the slope, if it exists, of the graph of the given linear equation.

29. $y=1.3x-5$
30. $y=-\frac{2}{5}x+7$
31. $x=-2$
32. $f(x)=4x-\frac{1}{4}$
33. $f(x)=-\frac{1}{2}x+3$
34. $y=\frac{3}{4}$
35. $y=9-x$
36. $x=8$
37. $y=0.7$
38. $y=\frac{4}{5}-2x$

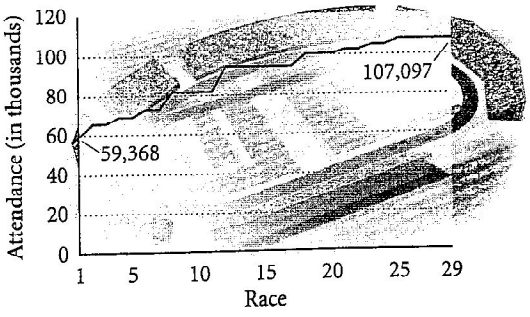
39. *Honey Production.* U.S. honey producers turned out 22% less honey in 2006 than in 1997. In 1997, approximately 198.2 million lb were produced. This amount decreased to 154.8 million lb in 2006. (*Source*: National Agricultural Statistics Services) Find the average rate of change in the number of pounds of honey produced from 1997 to 2006.



40. *HIV Cases.* HIV, human immunodeficiency virus, spreads to 10 people every minute. It is estimated that there were about 40.3 million cases of HIV worldwide in 2005. The estimated number of cases in 1985 was about 2 million. (*Source*: UNAIDS) Find the average rate of change in the number of adults and children worldwide with HIV from 1985 to 2005.

41. *Richmond International Raceway.* The 29 NASCAR races from March 1992 to May 2006 at Richmond International Raceway, Richmond, Virginia, were sellouts. Ticket sales increased over 80%. Use the data in the graph below to find the average rate of change in attendance for the consecutive races.

NASCAR Races at Richmond International Raceway



Source: NASCAR, Richmond International Raceway

42. *Decline in Teen Smoking.* The percent of 10th-grade students who have smoked daily in the last 30 days has greatly decreased, from 16.3% in 1995 to 8.3% in 2004 (*Source*: *Monitoring the Future*, University of Michigan Institute for Social Research and National Institute on Drug Abuse). Find the average rate of change over the 9-yr period in the percent of 10th-grade students who have smoked daily in the last 30 days.

43. *Decline in Land-Line Phones.* The number of land-line phones in the United States has decreased from 191 million in 2001 to 172 million in 2006 (*Source*: Federal Communications Commission). Find the average rate of change in the number of land-line phones over the 5-yr period.

44. *Credit-Card Debt.* From 1992 to 2006, the average household credit-card balance has risen 172%. Use the data in the graph below to find the average rate of change in the average credit-card balance from 1992 to 2006.

Credit Card Debt

Source: CardWeb.com, Paul Bannister, Bankrate.com, and "High Credit Card Debt Shouldn't Be Taken Lightly," Jeff Reish, *Canon Daily Record*, 4/22/2006

45. *Running Rate.* Lucie Mays-Sulewski, from Westfield, Indiana, won the women's division of the 2006 Indianapolis 500 Mini-Marathon race. The first American woman to win this race since 1993, she reached the 5-mi point after 31 min 10 sec and arrived at the 10-mi point after 1 hr 1 min 38 sec. (*Source*: www.500festival.com) Find Lucie's speed in miles per minute (average rate of change) from the 5-mi point to the 10-mi point.

46. *Work Rate.* As a typist resumes work on a research paper, $\frac{1}{6}$ of the paper has already been keyboarded. Six hours later, the paper is $\frac{3}{4}$ done. Calculate the worker's typing rate.

Find the slope and the y-intercept of the line with the given equation.

47. $y = \frac{3}{5}x - 7$

48. $f(x) = -2x + 3$

49. $x = -\frac{2}{5}$

50. $y = \frac{4}{7}$

51. $f(x) = 5 - \frac{1}{2}x$

52. $y = 2 + \frac{3}{7}x$

53. $3x + 2y = 10$

54. $2x - 3y = 12$

55. $y = -6$

56. $x = 10$

57. $5y - 4x = 8$

58. $5x - 2y + 9 = 0$

59. $4y - x + 2 = 0$

60. $f(x) = 0.3 \div x$

Graph the equation using the slope and the y-intercept.

61. $y = -\frac{1}{2}x - 3$

62. $y = \frac{3}{2}x + 1$

63. $f(x) = 3x - 1$

64. $f(x) = -2x + 5$

65. $3x - 4y = 20$

66. $2x + 3y = 15$

67. $x + 3y = 18$

68. $5y - 2x = -20$

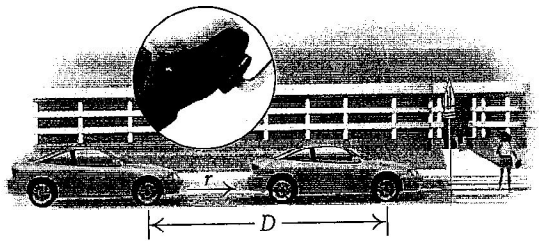
69. *Minimum Ideal Weight.* One way to estimate the minimum ideal weight of a woman in pounds is to multiply her height, in inches, by 4 and subtract 130. Let W = the minimum ideal weight and h = height.
   a) Express W as a linear function of h.
   b) Graph W.
   c) Find the minimum ideal weight of a woman whose height is 62 in.

70. *Pressure at Sea Depth.* The function P, given by
$$P(d) = \frac{1}{33}d + 1,$$
gives the pressure, in atmospheres (atm), at a depth d, in feet, under the sea.
   a) Graph P.
   b) Find $P(0)$, $P(5)$, $P(10)$, $P(33)$, and $P(200)$.

71. *Stopping Distance on Glare Ice.* The stopping distance (at some fixed speed) of regular tires on glare ice is a function of the air temperature F, in degrees Fahrenheit. This function is estimated by
$$D(F) = 2F + 115,$$
where $D(F)$ is the stopping distance, in feet, when the air temperature is F, in degrees Fahrenheit.
   a) Graph D.
   b) Find $D(0°)$, $D(-20°)$, $D(10°)$, and $D(32°)$.
   c) Explain why the domain should be restricted to $[-57.5°, 32°]$.

72. *Anthropology Estimates.* Consider Example 9 and the function
$$M(x) = 2.89x + 70.64$$
for estimating the height of a male.
   a) If a 26-cm humerus from a male is found in an archeological dig, estimate the height of the male.
   b) What is the domain of M?

73. *Reaction Time.* Suppose that while driving a car, you suddenly see a school crossing guard standing in the road. Your brain registers the information and sends a signal to your foot to hit the brake. The car travels a distance D, in feet, during this time, where D is a function of the speed r, in miles per hour, of the car when you see the crossing guard. That reaction distance is a linear function given by
$$D(r) = \frac{11}{10}r + \frac{1}{2}.$$



   a) Find the slope of this line and interpret its meaning in this application.
   b) Graph D.
   c) Find $D(5)$, $D(10)$, $D(20)$, $D(50)$, and $D(65)$.
   d) What is the domain of this function? Explain.

74. *Straight-Line Depreciation.* A marketing firm buys a new color printer for \$5200 to print banners for a sales campaign. The printer is purchased on January 1 and is expected to last 8 yr, at the end of which time its *trade-in*, or *salvage, value* will be \$1100. If the company figures the decline or depreciation in value to be the same each year, then the salvage value V, after t years, is given by the linear function
$$V(t) = \$5200 - \$512.50t, \quad \text{for } 0 \le t \le 8.$$
   a) Graph V.
   b) Find $V(0)$, $V(1)$, $V(2)$, $V(3)$, and $V(8)$.
   c) Find the domain and the range of this function.

75. *Total Cost.* The Cellular Connection charges \$60 for a phone and \$29 per month under its economy plan. Write an equation that can be used to determine the total cost, $C(t)$, of operating a Cellular Connection phone for t months. Then find the total cost for 6 months.

76. *Total Cost.* Superior Cable Television charges a \$65 installation fee and \$105 per month for "deluxe" service. Write an equation that can be used to determine the total cost, $C(t)$, for t months of deluxe cable television service. Then find the total cost for 8 months of service.

In Exercises 77 and 78, the term ***fixed costs*** *refers to the start-up costs of operating a business. This includes machinery and building costs. The term* ***variable costs*** *refers to what it costs a business to produce or service one item.*

77. Ty's Custom Tees experienced fixed costs of \$800 and variable costs of \$3 per shirt. Write an equation that can be used to determine the total costs encountered by Ty's Custom Tees when x shirts are produced. Then determine the total cost of producing 75 shirts.

78. It's My Racquet experienced fixed costs of \$950 and variable costs of \$24 for each tennis racquet that is restrung. Write an equation that can be used to determine the total costs encountered by It's My Racquet when x racquets are restrung. Then determine the total cost of restringing 150 tennis racquets.

Collaborative Discussion and Writing

79. Discuss why the graph of a vertical line $x = a$ cannot represent a function.

80. Explain as you would to a fellow student how the numerical value of slope can be used to describe the slant and the steepness of a line.

Skill Maintenance

If $f(x) = x^2 - 3x$, find each of the following.

81. $f\left(\frac{1}{2}\right)$

82. $f(5)$

83. $f(-5)$

84. $f(-a)$

85. $f(a + h)$

Synthesis

86. *Grade of Treadmills.* A treadmill is 5 ft long and is set at an 8% grade. How high is the end of the treadmill?

Find the slope of the line containing the given points.

87. $(-c, -d)$ and $(9c, -2d)$

88. $(r, s + t)$ and (r, s)

89. $(z + q, z)$ and $(z - q, z)$

90. $(-a - b, p + q)$ and $(a + b, p - q)$

91. (a, a^2) and $(a + h, (a + h)^2)$

92. $(a, 3a + 1)$ and $(a + h, 3(a + h) + 1)$

Suppose that f is a linear function. Determine whether the statement is true or false.

93. $f(cd) = f(c)f(d)$

94. $f(c + d) = f(c) + f(d)$

95. $f(c - d) = f(c) - f(d)$

96. $f(kx) = kf(x)$

Let $f(x) = mx + b$. Find a formula for $f(x)$ given each of the following.

97. $f(x + 2) = f(x) + 2$

98. $f(3x) = 3f(x)$